

Quarterly Progress Report

Project No. DE-FC26-05NT42304

Lovelace Biomedical and Environmental Research Institute  
Albuquerque, NM

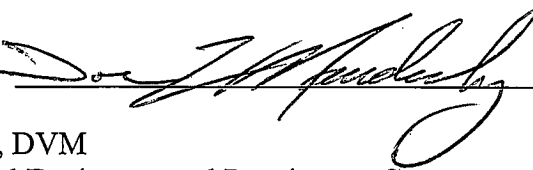
Health Effects of Subchronic Inhalation of Simulated Downwind  
Coal Combustion Emissions

Quarter 5

February 1, 2006 – April 30, 2006

Project Director: \_\_\_\_\_

Date \_\_\_\_\_

  
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## 1. Executive Summary

This Report describes progress during the fifth calendar quarter of project DE-FC26-05NT42304 "Health Effects of Subchronic Inhalation of Simulated Downwind Coal Combustion Emissions". The project was initiated on February 3, 2005. This report describes progress through April 2006.

The purpose of this project is to conduct a comprehensive laboratory-based evaluation of selected respiratory and cardiac health hazards of repeated, subchronic (up to 6 months) inhalation of simulated key components of "downwind" emissions of coal combustion. This project is being performed as an integral part of a joint government-industry program termed the "National Environmental Respiratory Center" (NERC), which is aimed at disentangling the roles of different physical-chemical air pollutants and their sources in the health effects associated statistically with air pollution. The characterization of the exposure atmosphere and the health assays will be identical to those employed in the NERC protocols used to evaluate other pollution source emissions.

The project has two phases, each encompassing multiple tasks. Guidelines for the composition of the exposure atmosphere were set by consensus of an expert workshop. The capability to generate the exposure atmosphere, and pilot studies of the comparative exposure composition using two coal types, will be accomplished in Phase 1. In Phase 2, the toxicological study will be conducted using one of the coal types tested in Phase 1. This project provides 50 % support for the work in Phase 1 and 20% support for the work in Phase 2.

As anticipated, progress during this reporting period caught up most of the delay incurred by previous technical issues, and the project is now back on schedule. Work during this period included completion of Phase 1, Task 2 (conducting iterative generation trials with Powder River Basin [PRB] coal), and completion of Phase 1, Task 3 (conducting iterative generation trials with Central Appalachian Low-Sulfur [CALS] coal). Iterative generation trials achieved the desired exposure with PRB coal, once the coal feeding problem was resolved. Generation trials with CALS coal progressed much more quickly, because the generation system has already been refined and its operation standardized. Only minor adjustments were required to hit targets with CALS coal. In addition to completing the requirements of this project, we accomplished acute inhalation exposures of animals as a preliminary comparison of toxicity of the two coal atmospheres. That work, although neither required nor funded by this project, will provide additional input into the selection of coal for the subchronic study (Phase 2). The results of the generation trials and toxicity tests will be discussed at the annual NERC meeting on May 16-17, 2006. Following that meeting, we will summarize results in a report (Phase 1, Task 4), which will complete Phase 1, and is scheduled by the end of May. Thus, the project is back on (or very near) the original schedule. In summary, progress during this reporting period included:

- Completion of generation trials with PRB coal
- Completion of generation trials with CALS coal
- Analysis of detailed data for the two atmospheres
- Conduct of ancillary animal inhalation toxicity tests.

## **2. Results of Work During Reporting Period**

### **a. Approach**

The general approach taken in this project has not changed from that described in the application. The approach to Phase 1, Task 2 involves conducting iterative generation trials with PRB coal in an attempt to meet the target ratios of particulate and non-particulate components at target total particle mass concentrations. These trials will serve to work out any technical problems that we may encounter in the generation system. Task 3 then repeats the iterative generation trials with CALS coal. The results from the two coals will then be compared to determine: a) whether or not it is equally practical to conduct the subchronic exposures with either coal, and b) comparative composition differences that might provide a basis for selecting the coal for the subchronic study. The results will be summarized in a report, which will comprise Phase 1, Task 4, and thus complete Phase 1.

The last progress report described progress toward accomplishment of Phase 1, Task 2. We have now completed Phase 1, Tasks 2 and 3, and are finalizing the detailed analytical data that will be included in the report (Task 4). The project is back on the original schedule at this time. The schedule called for completion of the report by the end of May 2006. We will present results at the annual meeting of the NERC program (which is co-funding this project) on May 16-17, 2006, and will delay development of the report until that discussion is completed. Thus, Phase 1 will be completed either on, or very near, the original schedule.

### **b. Activities and Progress**

#### **1. Characterization of Coal**

As described in the last report, the Powder River Basin Sub-Bituminous (PRB) and the Southern Appalachian Low Sulfur Bituminous (CALS) coals were characterized by standard Proximate and Ultimate analyses at Geochemical Testing Inc. based in Somerset, PA. This analytical strategy and source were recommended by UND/EERC, and will provide a characterization comparable to that used throughout the industry. Results of these analyses are in hand, will be presented at the NERC meeting, and will be included in the Phase 1, Task 4 report.

#### **2. Management of Coal**

The coals are stored in closed containers under nitrogen to purge oxygen that might cause oxidative chemical reactions. Although the PRB coal aerosolized well when taken from storage, we found that the CALS coal required mild heating (dehumidification) overnight to reduce "stickiness" and aerosolize satisfactorily.

#### **3. Adjustment of the Combustion/dilution system:**

The system design described in the last report proved satisfactory for generating atmospheres from both coals. The major hurdle was satisfactory aerosolization, and

the screw feed mechanism proved adequate. Sufficient carbon burn-out of the PRB coal was readily achieved. After combusting the PRB coal, we found it necessary to adjust temperature-time profiles to achieve adequate carbon burnout of the CALS coal. This difference was predicted, based on the known properties of the two coals and experience at UND/EERC. The higher sulfur content of the CALS coal also required adjustments of the sulfate and SO<sub>2</sub> inputs to the mixed atmosphere, but this was also predicted and was achieved without difficulty.

#### 4. Completion of Generation Trials

The detailed results from the generation trials are currently being assembled for presentation at the NERC meeting, followed by development of the Task 4 report. The results are not yet ready for inclusion in this report, which covers work through April, 2006. The following table summarizes some of the key components of the final trial atmospheres generated from the two coals, using target values for the highest exposure concentration.

Table 1. Achievement of Target Values for Key Components Using Two Coals

	Particle Mass <sup>a</sup> <u>µg/m<sup>3</sup></u>	NO <u>ppb</u>	NO <sub>2</sub> <u>ppb</u>	SO <sub>2</sub> <u>ppb</u>	HNO <sub>3</sub> <u>ppb</u>
Target Concentrations	1000	600	300	200	100
Achieved Concentrations:					
Powder River Basin Sub-bituminous Coal (PRB)					
Measured	1129	605	308	234	111
% of target	113	101	103	117	111
Central Appalachian Low-Sulfur Coal (CALS)					
Measured	1072	623	313	235	110
% of target	107	104	104	118	110

<sup>a</sup> Particle mass is a 100:1 ratio of sulfate to ash

The above results indicate that the target concentrations of major constituents of the target exposure atmosphere can be achieved. Once it was determined that we could achieve the approximate target concentrations, we moved forward without taking the time to trim the components to the precise target values. This will not be difficult and will certainly be done for the subchronic study, but will require balancing the entire exposure system, rather than working at only one exposure level. This would take additional time and was not necessary in order to achieve the goals of Phase 1 tasks: a) determine feasibility of achieving the target values using either coal; and b) collect samples for detailed analysis of the lesser chemical components. Once the coal for the subchronic study is selected, generation trials will resume with the study coal, concentrations will be trimmed to target values as precisely as practical, and the entire generation/exposure system will be balanced to ensure the proper dilutions at all exposure levels.

## **5. Ancillary Evaluation of Responses to Acute Inhalation Exposure**

With funding from the Electric Power Research Institute (EPRI), we conducted short inhalation exposures of rats to explore the acute lung toxicity of the two coal atmospheres listed in the above table. This was part of an EPRI-funded effort to build information bridges between the NERC and EPRI/DOE-funded TERESA program. While not part of either the NERC program or this project, the results may help inform the selection of coal for the subchronic study.

Male Sprague Dawley rats (10/group) were exposed once for 6 hours to atmospheres produced by either the PRB or CALS atmospheres at particle mass concentrations of 1000 or 300  $\mu\text{g}/\text{m}^3$ , or to clean air as controls. Exposures were conducted using a nose-only system connected to the output of the atmosphere mixing chamber. Immediately following exposure, photon emissions from oxidative reactions in lung, heart, and liver were measured by chemiluminescence. Tissues were then taken for measurement of thiobarbituric acid reactive substances (TBARS), an indicator of tissue lipid peroxidation, another index of oxidative stress.

The data from these exposures are being finalized and analyzed as this report is being written. They will be discussed at the NERC meeting.

### **c. Results and Discussion**

The primary results completed during the quarter are those shown in Table 1 above. Other results were generated, as described above, but were not completed and analyzed during the quarter. All results generated to date will be shown and discussed at the NERC meeting on May 16-17, 2006, and all results pertaining to this project will be summarized in the Phase 1 report.

The key accomplishment during the quarter was confirmation that the subchronic exposure atmosphere could plausibly be generated using either PRB or CALS coal. This finding is significant to the selection of coal for the subchronic study, because it means that the selection is not bounded by an impossibility of conducting the study with one of the coals. The selection can now be made on the basis of detailed chemical results, results of the ancillary toxicity study, and other considerations.

### **d. Conclusions**

The project is back on schedule, and the fundamental aims of Phase 1 have been accomplished. We are now prepared to engage in discussions leading to the selection of coal for the subchronic study.

## **3. Milestones**

The project is back on schedule and the milestones pertinent to this reporting period have been met. Phase 1, Tasks 1, 2, and 3 are completed. Phase 1, Task 4 is underway, but is not yet

due for completion. At this time, there is no apparent technical barrier to completing the project as originally scheduled.

#### **4. Cost and Schedule Status**

##### **a. Cost Status**

DOE expenses as of 4/30/06:	\$ 298,655.15
LRRI cost share as of 4/30/06:	\$ 59,731.03
Other cost share as of 4/30/06:	<u>\$ 238,924.12</u>
Total expenditures as of 4/30/06:	\$ 597,310.30

##### **b. Schedule Status**

The project is on schedule.

#### **5. Significant Accomplishments**

Significant accomplishments during the past quarter are described in more detail above. In summary, we accomplished:

- completion of generation trials with PRB coal
- completion of generation trials with CALS coal
- production of detailed data for the two atmospheres
- conduct of ancillary animal inhalation toxicity tests.

#### **6. Problems, Delays, and Corrective Actions**

We have overcome past delays, and nothing is significantly obstructing progress at this time. There is no reason to believe that the project cannot be completed on approximately the original schedule.

#### **7. Technology Transfer Activities**

There have been no technology transfer activities or issues to date. It is not anticipated that this project will generate any intellectual property or technical advances that will raise technology transfer issues. The product of this project is explicitly information on the health effects of exposure to modified coal emissions, and that information is to be communicated to the scientific community, public, and other stakeholders through peer-reviewed, open literature publications.